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NAVAL OCEAN RESEARCH AND DEVELOPMENT ACTIVITY NSTL S--ETC F/G 17/5
COMPARISON OF MULTICHANNEL AND TWO-SATELLITE METHODS FOR REMOTE--ETC(U)
JUL 82 R HOLYER, J HAWKINS
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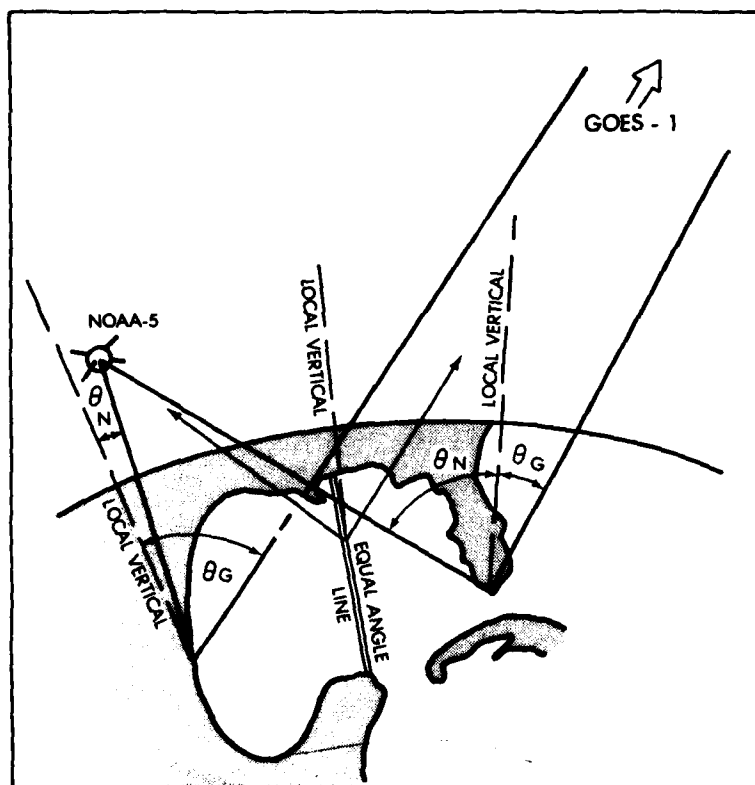
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NORDA Technical Note 162

Naval Ocean Research and
Development Activity
NSTL Station, Mississippi 39529



Comparison of Multichannel and Two-Satellite Methods for Remote Measurement of Sea Surface Temperature



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ABSTRACT

Atmospheric correction of IR satellite data for retrieval of sea surface temperatures (SST) by means of differential absorption can take on two forms. The most popular method utilizes changes in the spectral transmittance of the atmosphere between two or more IR channels (multichannel). The second form employs path length differences in the same spectral band using two satellites. The multichannel and two satellite approaches are applied to coincident imagery and in situ data and compared. In this test case the multichannel method resulted in a mean SST error of -3.3°C while the two satellite algorithm produced a mean error of -0.4°C . Based on radiative transfer calculations with the LOWTRAN-5A model, it is hypothesized that atmospheric aerosols are responsible for the poor performance of the multichannel method.

ACKNOWLEDGMENTS

This work was funded jointly under ONR program element 61153N, "Satellite Measurement of Sea Surface Temperature," and NAVAIR program element 62759N, "Satellite Data-Prediction Model Interaction."

The authors wish to acknowledge the excellent support of the Naval Oceanographic Office, Codes 7230 and 6421, in the collection of AXBT data utilized as surface truth in this report.

The NORDA Code 335 Interactive Digital Satellite Image Processing System (IDSIPS) was used for all image calibration, registration, and algorithm development.

CONTENTS

LIST OF ILLUSTRATIONS	iii
I. INTRODUCTION	1
II. VERIFICATION DATA	1
III. MULTICHANNEL METHOD	2
IV. TWO-SATELLITE METHOD	4
V. COMPARISON OF MCSST AND TSSST RESULTS	4
VI. DISCUSSION	5
VII. RADIATIVE TRANSFER CALCULATIONS	5
VIII. CHARACTERISTICS OF THE MARITIME AEROSOL	6
IX. CONCLUSIONS	8
X. REFERENCES	9

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ILLUSTRATIONS

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|-----------|--|---|
| Figure 1. | The percent transmittance of radiant energy as a function of wavelength for the spectral range which includes the IR channels on the present NOAA series of meteorological satellites. | 3 |
| Figure 2. | Atmospheric attenuation at AVHRR channel 4 wavelengths ($11\ \mu\text{m}$) vs. attenuation at channel 3 wavelengths ($3.7\ \mu\text{m}$) based on LOWTRAN-5A calculations for various model atmospheres with and without maritime aerosols. Solid curve is best fit resulting from similar work by Deschamps and Phulpin (1980). Region to the left of the dotted line is the rejection region for the NOAA-NESS Low Stratus Test. | 3 |
| Figure 3. | Error in MCSST vs. scan angle based on LOWTRAN-5A calculations for a mid-latitude winter atmospheric model with a surface temperature of 22°C . Errors are plotted for both the NOAA-NESS (McClain, 1981) and the Deschamps and Phulpin (1980) algorithms. | 7 |
| Figure 4. | LOWTRAN-5A calculated spectral transmittance of the 1962 U.S. Standard Atmosphere with and without inclusion of the maritime haze model. | 7 |

TABLES

- | | | |
|----------|-----------------------------|---|
| Table 1. | MCSST and TSSST comparisons | 4 |
|----------|-----------------------------|---|

COMPARISON OF MULTICHANNEL AND TWO-SATELLITE METHODS FOR REMOTE MEASUREMENT OF SEA SURFACE TEMPERATURE

I. INTRODUCTION

For years, the problem of atmospheric corrections has limited oceanographic uses of infrared (IR) imagery to qualitative identification of ocean thermal features. The atmospheric attenuation of the IR signal effectively suppresses the actual sea surface temperature (SST) and the SST gradients. Over the last decade, scientists have addressed the problem by postulating or testing the use of multiple IR channel data to adjust for the intervening atmosphere (Anding and Kauth, 1970; Prabhakara et al., 1974; McMillin, 1975; Deschamps and Phulpin, 1980; and others). The National Earth Satellite Service (NESS) has performed atmospheric corrections and produced operational quantitative SST products since 1972 (McClain, et al. 1982), but the early efforts were not completely satisfactory.

Only recently have accurate quantitative measurements resulted from IR digital imagery. The Advanced Very High Resolution Radiometers (AVHRR) on TIROS-N, NOAA-6, and NOAA-7 all were configured with multiple IR channels and high thermal resolution. The different atmospheric transmittances in these channels have enabled scientists to correct the IR signal that is atmospherically attenuated, largely by water vapor and aerosols. Successful tests of multiple window atmospheric corrections with NOAA-7 data at the National Oceanic and Atmospheric Administration (NOAA)-NESS (McClain, 1981) prompted the use of multichannel SST (MCSST) methods in NOAA SST analysis beginning November 1981.

Another approach to the IR attenuation problem is to utilize two satellites with at least one IR channel viewing the same ocean surface. This possibility was examined theoretically by McMillin (1975). Holyer (1982) has proven that atmospheric corrections can be applied when coincident Geostationary Operational Environmental Satellite (GOES) and NOAA-6 images are available. This report summarizes both theories, and reports the results of the first quantitative comparison between the methods. An attempt is then made to explain the unexpected results of this comparison.

II. VERIFICATION DATA

The comparison data used for this study incorporates multichannel IR data from NOAA-6 (Channels 3 and 4) and 10.5-12.5 μm data from GOES-East on February 4, 1980, over the Gulf of Mexico. The polar orbiter pass at 1308Z (7:08 AM CST) revealed the northern Gulf had clear skies, while partly cloudy conditions existed southward over the Loop Current. A corresponding GOES-E IR image at 1200Z was processed for this analysis.

Surface truth for the comparison was obtained from a variety of platforms. A NAVOCEANO P-3 flight provided accurate SST and subsurface thermal structure data via airborne expendable bathythermographs (AXBT) and a Precision Radiation Thermometer (PRT-5). NOAA Data Buoy Office (NDBO) buoys and National Marine Fisheries Service (NMFS) COOP XBT and Japanese tuna boat bucket temperatures increased the available verification SST observations to 64. However, cloud screening procedures eliminated many of these possible surface truth points that occurred within 12 hours of the satellite overpass.

Obvious cloud or land contaminated picture elements (pixels) were deleted by first restricting the usable range to 10-30°C. This range encompasses all valid

Gulf of Mexico SSTs except for those in extremely shallow water, especially near the mouth of the Mississippi River. At those surface truth locations where the satellite temperatures passed the range test, a 5x5 array of pixels centered on the surface truth location was then screened in NOAA-6 channel 4, so that only those that contained a variance of less than 0.3°C about the mean were retained. Only seven of the possible 64 surface truth points survived these screening procedures.

The dual-window MCSST algorithms evaluated here are normally for nighttime data only, since AVHRR channel 3 is susceptible to sun glint. The nadir track of orbit 3154 was east of the test area, thus the sensor was scanning west toward the area of interest. This westward-looking orientation should avoid all possibility of sun glint contamination even though this early morning pass was in daylight conditions. Calculations using the visible NOAA-6 channels indicated the reflectance values at the locations of the seven remaining surface truth points were <5.0% in each case, thus confirming the absence of sun glint. These "cloud free" surface points serve as verification points for testing MCSST and two satellite SST (TSSST) algorithms.

It should be noted as background information for this accuracy evaluation study that the calibration accuracy of NOAA-6 has been in doubt since Otis Brown at the University of Miami reported calibration problems shortly after launch. Subsequently, NOAA-NESS issued the following statement in February 1981 in APT 81-1:

Those individuals/organizations concerned with the precise thermal calibrations should be aware that a 2 degree K thermal gradient exists across the backscan housing area of the NOAA-6 AVHRR instrument. (The backscan housing area is used by the AVHRR as a blackbody target for thermal calibration). When calculating thermal calibration coefficients a simple arithmetic mean of the four PRT sensors is representative of the target area temperature and can be used in these calculations.

III. MULTICHANNEL METHOD

The principle behind the multichannel correction is illustrated in Figure 1. The two IR channels aboard NOAA-6 (3.55-3.93 μm) and (10.5-11.5 μm), referred to as 3.7 μm and 11 μm , respectively, fall within "atmospheric windows." These spectral bands thus have relatively high transmittances with regard to middle and far infrared energy emitted by the ocean surface. The most significant atmospheric absorption constituents in these regions are water vapor and aerosols. However, the 3.7 μm channel has a transmittance of ~90% compared to ~75% for the 11 μm channel. This variation in infrared transmittance between the two channels (differential absorption) allows a correction to be made for atmospheric effects (Anding and Kauth, 1970).

High noise levels in the TIROS-N channel 3 data precluded any real use of multichannel algorithms on this data. NOAA-6 multichannel data has been used for research purposes (detailed later) but was never used operationally due to software limitations. Offline tests with NOAA-7 data at NOAA-NESS in 1981 proved that accurate SST retrievals (RMS < 1.0°C) could be derived. These promising results convinced NESS to operationally replace single IR channel derived SSTs (corrected with data from the atmospheric sounder) in the GOSSTCOMP analysis with MCSSTs on November 17, 1981.

A large verification program is now in effect at NESS using fixed and drifting buoys. Early results show that a global RMS of <1.0°C is being reached with a small (-0.5°C) bias on the cold side (McClain, et al. 1982). These positive results

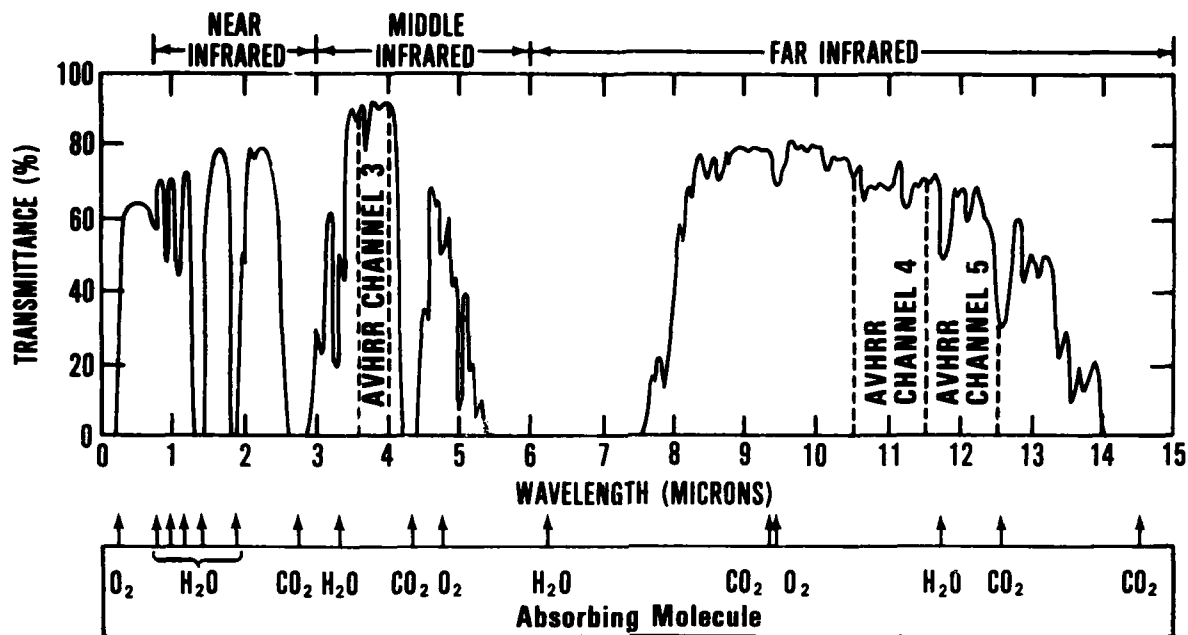


Figure 1. The percent transmittance of radiant energy as a function of wavelength for the spectral range which includes the IR channels on the present NOAA series of meteorological satellites.

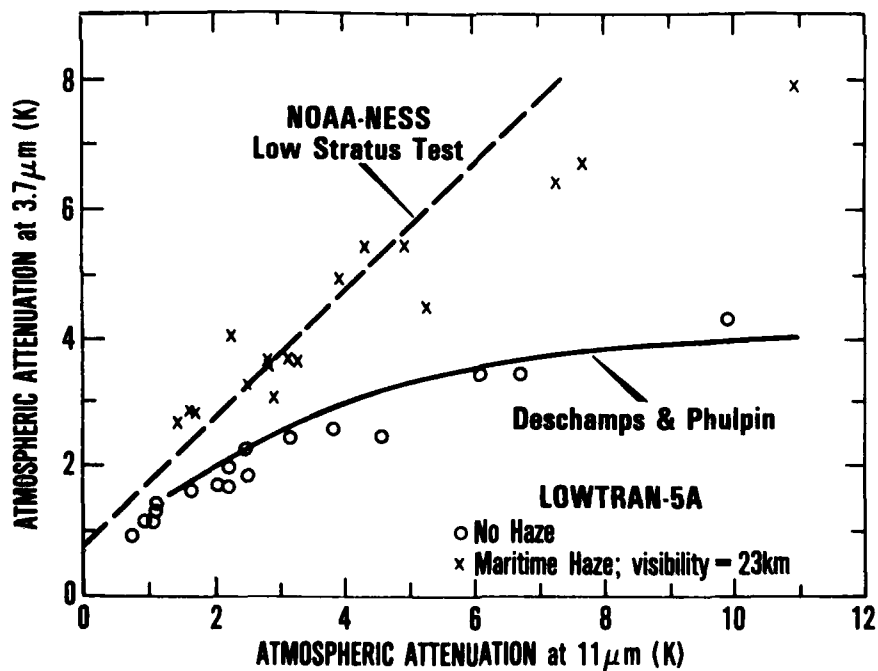


Figure 2. Atmospheric attenuation at AVHRR channel 4 wavelengths ($11 \mu\text{m}$) vs. attenuation at channel 3 wavelengths ($3.7 \mu\text{m}$) based on LOWTRAN-5A calculations for various model atmospheres with and without maritime aerosols. Solid curve is best fit resulting from similar work by Deschamps and Phulpin (1980). Region to the left of the dotted line is the rejection region for the NOAA-NESS Low Stratus Test.

prompted NORDA Code 335 to encourage Fleet Numerical Oceanography Center (FNOC) to again include satellite SSTs in their SST analysis. Jim Cornelius and others at FNOC made it possible for this to become operational May 23, 1982, using one 8 km MCSST retrieval received from NESS in each 2.5 x 2.5 degree box (due to slow data rate of the communication line). The following sections present the first NORDA effort to compare the MCSST and TSSST algorithms and explore any discrepancies that result. This will directly benefit FNOC products and the satellite-numerical ocean model interaction project that exists between NORDA Codes 335 and 322.

IV. TWO-SATELLITE METHOD

The two-satellite method utilizes near simultaneous coverage by two satellites (normally one geostationary and one polar orbiter, as depicted on the front cover) to make a correction based on temperature differences resulting from different atmospheric path lengths for the satellites as they view a given point. A simple radiative transfer model of the atmosphere is used to translate geometrical parameters and temperature differences into atmospheric corrections. A complete description of the TSSST method is in press (Holyer, 1982). The first evaluation of TSSST utilized data from the Gulf of Mexico in December 1978. The results were good, but it was not possible to perform a comparison with MCSST because multispectral satellite IR data was not available at that time. The present data set is the second evaluation of TSSST but the first MCSST/TSSST comparison.

V. COMPARISON OF MCSST AND TSSST RESULTS

The results of the application of the two methods to the NOAA-6 data previously described are shown in Table 1 for the seven data points which passed the cloud contamination screening.

Table 1. MCSST and TSSST comparisons

Ground Truth AXBT Temp	TSSST		MCSST	
	SST	Error	SST	Error
20.4	19.9	-0.5	17.3	-3.1
21.0	20.3	-0.7	17.8	-3.2
21.3	20.8	-0.5	18.0	-3.3
23.7	21.0	-2.7	19.4	-4.3
24.3	21.7	-2.6	20.8	-3.5
24.4	22.7	-1.7	21.6	-2.8
24.1	23.0	-1.1	21.1	-3.0
Mean Error		-1.4		-3.3
RMS Error		0.88		0.43
Expected Bias (see below)		-1.0		0.0
True Error		-0.4		-3.3

The NAVOCEANO P-3 aircraft that dropped the AXBTs was equipped with a PRT-5 radiometer to measure the radiometric skin temperature of the ocean. Comparison of radiometric temperatures (after careful calibration and atmospheric correction) with AXBT temperatures shows the skin/subsurface differential to average -1.0°C for the seven ground truth locations given in Table 1. The TSSST method retrieves radiometric temperatures, so a mean error of -1.0°C is expected when TSSST values are compared with AXBT data. The MCSST method, on the other hand, is reportedly bias corrected to give a zero mean relative to subsurface contact temperatures. Thus, the mean errors for the TSSST and MCSST methods are actually -0.4 and -3.3°C , respectively.

VI. DISCUSSION

The small number of data points precludes any precise quantitative comparison of TSSST and MCSST. However, in this first head-to-head competition, the TSSST algorithm significantly outperformed the MCSST. The -3.3°C bias in MCSST comes as a surprise in light of the fact that the latest figures from NOAA-NESS (McClain, et al. 1982) show a bias of $<-0.42^{\circ}\text{C}$ based on 267 comparisons of NOAA-7 data with drifting buoy observations. Early NESS work with NOAA-6 data indicated a bias of -0.6°C (McClain, 1980).

As for other satellite sea surface temperature researchers, the University of Miami/Rosenstiel School of Marine and Atmospheric Science (RSMAS) is using the same NOAA-NESS algorithm as is used here, typically finding a bias of -1.0°C with NOAA-6 data (O. B. Brown, personal communication, 1982). Dr. Brown also indicates that Dr. Bernstein at the Scripps Institution of Oceanography (SIO), using the dual window algorithms of Deschamps and Phulpin (1980), is finding a bias of -0.8°C for NOAA-6. If NOAA-NESS, RSMAS, and SIO are finding biases ranging from -0.60 to -1.0°C , then why does the present data result in a -3.3°C bias?

The obvious first guess at an answer to this question is that some error exists in the NOAA-6 software or in the way the algorithm is being applied. However, careful checking of NORDA software has not yet revealed any such bugs. As indicated previously, the calibration of the NOAA-6 AVHRR instrument has been questioned in the past. However, since RSMAS and SIO get reasonable results from NOAA-6 and TSSST results reported here are fairly accurate, it does not appear at this time that the large MCSST bias can be attributed to sensor miscalibration. This, then, rules out all the easy answers.

VII. RADIATIVE TRANSFER CALCULATIONS

The LOWTRAN-5A computer code (Kneizys et al., 1980) was used to perform atmospheric radiative transfer calculations to shed light on the large negative MCSST bias problem. Since the Deschamps and Phulpin (1980), henceforth referred to as DP, algorithms were derived using the LOWTRAN code (version 3B rather than 5A), the first step was to try to duplicate the DP results. The DP work involved the six model atmospheres provided by the LOWTRAN code: tropical, mid-latitude summer, mid-latitude winter, sub-arctic winter, sub-arctic summer, and U.S. standard. For each model three surface temperatures and two scan angles were used giving a total of 36 possible combinations. Only 17 of the possible 36 points are reproduced here, but these are enough points to determine if the DP results could be duplicated. A figure similar to one from DP is shown here as Figure 2 where atmospheric attenuation in AVHRR channel 3 is plotted against attenuation in AVHRR channel 4. The solid line in Figure 2 is the best fit to the 36 points of DP. LOWTRAN provides haze or aerosol

models as an option in the program. It was found that in order for LOWTRAN-5A to reproduce the DP line all aerosol calculations had to be eliminated. Without aerosol effects, our results for the 17 atmospheric combinations (shown as circles in Figure 2) are quite close, but not identical to the line in Figure 2. The slight difference probably results from the fact that DP used "nominal" spectral response curves for the AVHRR, while this study used actual NOAA-6 values. Also some minor adjustments have been made to LOWTRAN between versions 3B and 5A. The present calculations were close enough to DP to conclude that (a) LOWTRAN-5A, recently operational at NORDA, was working correctly, and (b) the DP algorithms were based on radiative transfer calculations that did not include aerosol effects.

The second step in radiative transfer calculations was to include the effects of aerosols by invoking the maritime haze model in LOWTRAN-5A and repeating the 17 points in Figure 2. The maritime haze model results are shown with x's in Figure 2 where they differ significantly from the no-haze case. Could aerosols in the February 4, 1980, data be responsible for the -3.3°C bias?

The LOWTRAN-5A code was used to simulate the February 4 data by using the mid-latitude winter atmospheric model and specifying the surface temperature to be 22°C . The apparent surface temperatures, as sensed from satellite altitude in AVHRR channels 3 and 4, were calculated for this situation with and without maritime haze for scan angles from 0 to 50 degrees. These simulated temperatures were input to both the NOAA-NESS and DP MCSST algorithms to retrieve an atmospherically corrected sea surface temperature. The results of this application of MCSST algorithms to simulated NOAA-6 data are shown in Figure 3 where MCSST error is plotted as a function of scan angle for no haze and maritime haze cases. From Figure 3 the following conclusions can be drawn:

- Both NOAA-NESS and DP algorithms give similar results.
- Without aerosols, the MCSST algorithms give accurate results with little angular dependency.
- With a maritime aerosol model included, both algorithms show a large negative error.
- When aerosols are included a strong angular dependency is exhibited as the expected bias ranges from -2.0°C at nadir to greater than -6.0°C near the ends of the scan line.
- Aerosol effects can be shown, via radiative transfer calculations, to produce MCSST errors comparable to the observed bias in the February 4, 1980, NOAA-6 data which did, incidently, come near the end of the AVHRR scan line.

VIII. CHARACTERISTICS OF THE MARITIME AEROSOL

A complete discussion of the properties of marine aerosols is beyond the scope of this report, but one aerosol property should be discussed. Figure 4 shows the transmittance (surface to space at a 45° angle with respect to vertical) of the U.S. Standard Atmosphere with and without a maritime haze. Note that the transmittance at AVHRR channel 3 wavelengths goes down relative to channel 4 wavelengths with the addition of the aerosols. This behavior is opposite the spectral behavior of water vapor, which attenuates more in channel 4 than in channel 3. In other words, the maritime aerosols, if present, will tend to cancel out the effect of the water vapor; hence, the dual-window MCSST correction method has a major drawback.

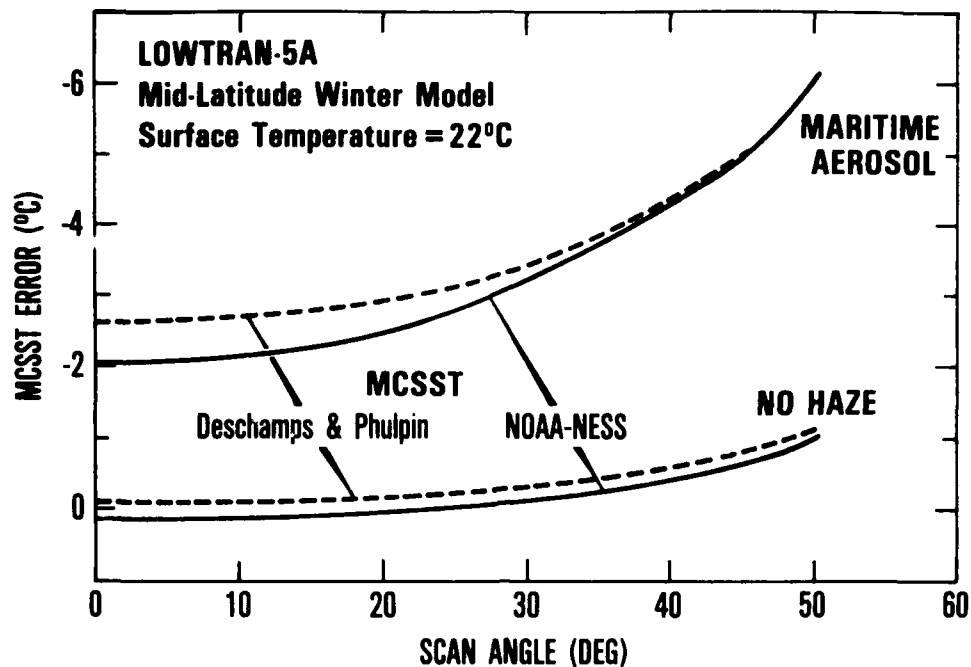


Figure 3. Error in MCSST vs. scan angle based on LOWTRAN-5A calculations for a mid-latitude winter atmospheric model with a surface temperature of 22°C. Errors are plotted for both the NOAA-NESS (McClain, 1981) and the Deschamps and Phulpin (1980) algorithms.

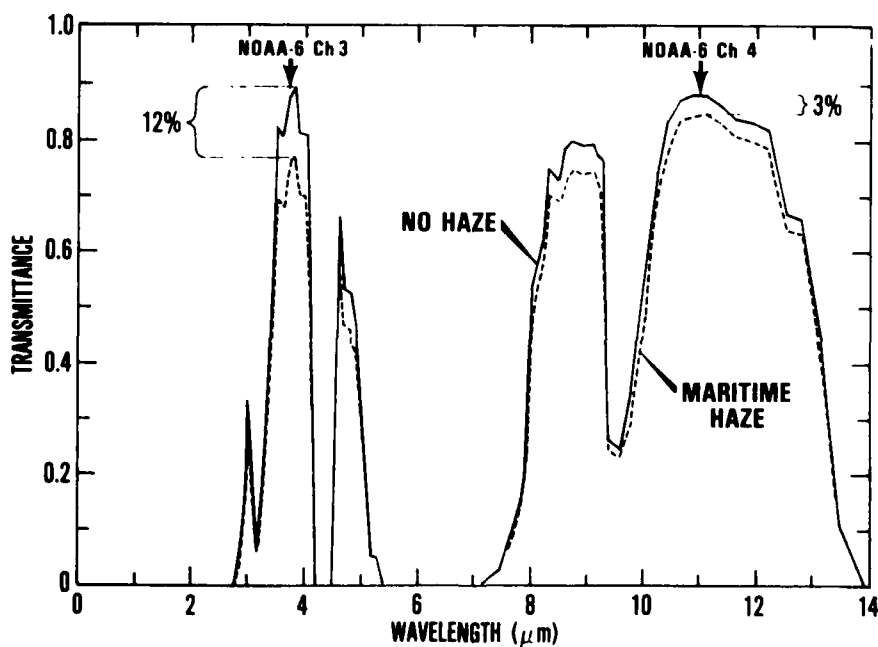


Figure 4. LOWTRAN-5A calculated spectral transmittance of the 1962 U.S. Standard Atmosphere with and without inclusion of the maritime haze model.

Why then do NOAA-NESS, RSMAS, and SIO get reasonably good MCSST retrievals. We don't know about RSMAS and SIO, but NOAA-NESS applies a number of "cloud screening" tests to the data (McClain, et al., 1982) that also appear to screen out high aerosol cases. Two NOAA-NESS tests seem especially relevant to the aerosol problem. First, the Low Stratus Test states that if the temperature in channel 4 is more than 0.7°K higher than the temperature in channel 3, the data is rejected. This test is represented by the dotted line in Figure 2, where the area to the left of the dotted line in Figure 2 is the rejection region. It can be seen that the LOWTRAN calculations predict that some of the clear sky with maritime aerosol cases will be eliminated by the Low Stratus Test. The second important test applied by NOAA-NESS to all daytime data is the Visible Cloud Test, which states that if the bidirectional reflectance measured by channel 2 (near-IR wavelengths) is >1.7%, the data is rejected. All seven points analyzed here would have failed the Visible Cloud Test even though they were cloud free. Thus, the NOAA-6 data processed here would have been rejected by the NOAA-NESS operational software presumably because of cloud contamination, but probably because of slightly increased near-IR reflectance resulting from the presence of maritime aerosols. It is, therefore, presently believed that NOAA-NESS is maintaining good accuracy in spite of the aerosol problem by using very restrictive cloud tests that are also eliminating data influenced by aerosols. This procedure is necessary to get good MCSST results and is acceptable as long as the problem is recognized. Users must realize that the price to be paid for the aerosol screening and resultant high accuracy is that one may obtain a relatively small number of retrievals even from areas that are actually cloud free.

IX. CONCLUSIONS

Any MCSST algorithm that is based on differential absorption in AVHRR channels 3 and 4 will be adversely affected by the presence of maritime aerosols. The nature of the degradation will be a negative bias, which can easily be 4-5°C in magnitude. The only way to avoid this problem is to screen the data to eliminate pixels influenced by aerosols via some very restrictive "cloud screening criteria." This, of course, throws out an unknown number of cloud-free data points, thus reducing the number of possible retrievals. The TSSST method, since it is based on increased attenuation with path length, is not adversely affected by aerosols. As a matter of fact, it does not know the difference between aerosols and water vapor. The TSSST algorithm simply corrects for whatever is there as long as the effects are a function of path length, as described in the TSSST radiative transfer model.

This conclusion is in agreement with the recent work of Chedin et al. (1982) where simulations of a two-satellite method were performed based on METEOSAT and TIROS-N High Resolution Infrared Sounder channel 8. Chedin et al. conclude:

(The two satellite) way of obtaining different amounts of atmospheric absorptions has an important advantage over the more usual way which consists in varying the wavelength. This advantage comes from the fact that the spectroscopic aspect of the problem has been almost completely eliminated. Indeed, the "anomalous" (or unknown) spectroscopic behavior of some of the components of the total absorption is still a source of trouble in a wavelength differential approach.

X. REFERENCES

- Anding, D. and R. Kauth (1970). Estimation of Sea Surface Temperature from Space. *Remote Sensing of Environment*, 1, 217-220.
- Chedin, A., N. A. Scott, and A. Benoit (1982). A Single-Channel, Double-Viewing Angle Method for Sea Surface Temperature Determination from Coincident METEOSAT and TIROS-N Radiometric Measurements. *J. Appl. Meteor.*, 21, 613-618.
- Deschamps, P. Y. and T. Phulpin (1980). Atmospheric Correction of Infrared Measurements of Sea Surface Temperature using Channels at 3.7, 11, and 12 μm . *Bound. Layer Meteor.*, 18, 131-143.
- Holyer, R. J. (1982). A Two-Satellite Method for Measurement of Sea Surface Temperature. Submitted to the *International J. Remote Sensing*.
- Kneizys, F. X., E. P. Shettle, W. O. Gallery, J. H. Chetwynd, Jr., L.W. Abren, J.E.A. Selby, R. W. Fern, R. A. McClatchey (1980). Atmospheric Transmittance/Radiance: Computer Code LOWTRAN-5. AFGRL-TR-80-0067, Air Force Geophysical Laboratory.
- McClain, E. P. (1980). Multiple Atmospheric-Window Techniques for Satellite-Derived Sea Surface Temperatures. *Proceed. of COSPAR Symposium on Oceanography from Space, COSPAR XXIII, Venice, Italy, 26-30 May, 1980.*
- McClain, E. P. (1981). Operational Implementation of AVHRR-only Multichannel Sea Surface Temperature Products, NOAA-NESS For the Record, 19 Nov 1981.
- McClain, E. P., W. G. Pichel, C. C. Walton, Z. Ahmad, and J. Sutton (1982). Multi-Channel Improvements to Satellite-Derived Global Sea Surface Temperatures. *Proceed. of COSPAR Symposium on Meteorological Observations from Space, COSPAR XXIV, Ottawa, Canada, 22-29 May 1982.*
- McMillin, L. M. (1975). Estimation of Sea Surface Temperatures from Two Infrared Window Measurements with Different Absorption; *J. Geophys. Res.*, 80, 5113-5117.
- Prabhakara, C., G. Dalu, and V.G. Kunde (1974). Estimation of Sea Surface Temperature from Remote Sensing in the 11 to 13 μm Window Region. *J. Geophys. Res.*, 79, 5039-5044.

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NORDA Technical Note 162	2. GOVT ACCESSION NO. AD-A118736	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Comparison of Multichannel and Two-Satellite Methods for Remote Measurement of Sea Surface Temperature		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Ron Holyer Jeff Hawkins		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Naval Ocean Research and Development Activity NSTL Station, Mississippi 39529 (Code 330, Ocean Acoustics Division)		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 61153N 62759N
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Ocean Research and Development Activity NSTL Station, Mississippi 39529 (Code 330)		12. REPORT DATE July 1982
		13. NUMBER OF PAGES 12
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Distribution Unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Sea Surface Temperature (SST) Atmospheric Corrections Multichannel SST Two-Satellite SST Differential Absorption Lowtran-5A Gulf of Mexico Remote Sensing		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) Atmospheric correction of IR satellite data for retrieval of sea surface temperatures (SST) by means of differential absorption can take on two forms. The most popular method utilizes changes in the spectral transmittance of the atmosphere between two or more IR channels (multichannel). The second form employs path length differences in the same spectral band using two satellites. The multichannel and two satellite approaches are applied to coincident imagery and in situ data and compared. In this test case the multichannel method		

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resulted in a mean SST error of -3.3°C while the two satellite algorithms produced a mean error of -0.4°C . Based on radiative transfer calculations with the LOWTRAN-5A model, it is hypothesized that atmospheric aerosols are responsible for the poor performance of the multichannel method.

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